REMARKS

I.   Status of the Application

Claims 1-28 are pending in this application. In the April 21, 2003 Office Action, the

Examiner:

A.   Rejected claims 1, 2, 8-9 and 12 under 35 U.S.C. § 102(b) as allegedly being

anticipated by U.S. Patent No. 5,640,242 to O'Boyle et al.; and

B.   Rejected claims 3-7, 10-11 and 13-28 under 35 U.S.C. §103(a) as allegedly

being unpatentable over U.S. Patent 5,640,242 to O'Boyle et al. in view of U.S. Patent

6,361,646 to Bibby, Jr. et al.

In this Response, Applicant respectfully traverses the foregoing rejections and

respectfully requests allowance of all claims in view of the following.

IN THE CLAIMS

The following is a listing of all claims:

1. (Currently Amended) A method of determining layer thickness of <u>a particular area of</u> a substrate during CMP of the substrate<u>, the method</u> comprising the steps of:

acquiring an image of ~~an~~ <u>a particular</u> area of the substrate using high speed imaging;

comparing the acquired high speed image to <u>each one of</u> a <u>plurality of stored image patterns</u> ~~predetermined pattern~~; and

converting the acquired high speed image into a layer thickness measurement when the acquired high speed image corresponds to <u>one of said plurality of stored image patterns</u> ~~the predetermined pattern~~.

2. (Currently Amended) The method of claim 1, wherein the step of acquiring a high speed image of ~~an~~ <u>a particular</u> area of the substrate includes the steps of:

projecting a conventional light source onto the substrate; and

utilizing a high speed camera.

3. (Currently Amended) The method of claim 1, wherein the step of acquiring a high speed image of ~~an~~ <u>a particular</u> area of the substrate includes the steps of:

delivering a pulse of light from a coherent light source onto <u>the particular area of</u> the substrate; and

utilizing a conventional camera.

4. (Original) The method of claim 3, wherein said coherent light source comprises a laser.

5. (Currently Amended) The method of claim 1, wherein the step of acquiring a high speed image of ~~an~~ a particular area of the substrate includes the steps of:

delivering a pulse of light from a broad band light source onto the particular area of the substrate; and

utilizing a conventional camera.

6. (Original) The method of claim 5, wherein the said broad band light source comprises a flash lamp.

7. (Original) The method of claim 1, wherein the step of converting the corresponding acquired high speed image into a thickness measurement includes the step of converting pixels of the acquired high speed image into layer thickness.

8. (Original) The method of claim 1, wherein said determination of layer thickness of the substrate is performed in situ.

9. (Currently Amended) An apparatus for determining layer thickness of a particular area of a substrate during CMP of the substrate comprising:

a high speed imager adapted to acquire an image ~~images~~ of a particular area ~~areas~~ of the substrate in situ;

a processing unit in electronic communication with said high speed imager;

memory in electronic communication with said processing unit and containing a plurality of instructions which, when executed by said processing unit, causes said processing unit to:

compare the image ~~images~~ acquired by said high speed imager to each one of a plurality of image patterns stored in said memory device; and

convert ~~an~~ the acquired image into a layer thickness measurement when said acquired image corresponds to a ~~predetermined~~ one of said plurality of image patterns stored in said memory device.

10. (Original) The apparatus of claim 9, wherein said high speed imager comprises:

a pulsed, coherent light source; and

a conventional camera.

11. (Original) The apparatus of claim 10, wherein said coherent light source comprises a laser.

12. (Original) The apparatus of claim 9, wherein said high speed imager comprises:

a conventional light source; and

a high speed camera.

13. (Original) The apparatus of claim 9, wherein said high speed imager comprises:

a pulsed, broad band light source; and

a conventional camera.

14. (Original) The apparatus of claim 13, wherein said broad band light source comprises a

flash lamp.

15. (Currently Amended) A method of determining end-point during CMP of a substrate

comprising the steps of:

acquiring ~~images~~ an image of an area of the substrate using a high speed imager;

comparing the acquired ~~images~~ image to stored image patterns;

converting ~~an~~ the acquired image into a layer thickness measurement when the

acquired images corresponds to ~~a predetermined~~ one of the compared stored image ~~pattern~~

patterns; and

stopping CMP when the layer thickness measurement is a predetermined valued

indicating end-point.

16. (Currently Amended) The method of claim 15, wherein the step of acquiring ~~images~~ an

image of an area of the substrate includes the steps of:

projecting a conventional light source onto the area of the substrate; and

utilizing a high speed camera.

17. (Currently Amended) The method of claim 15, wherein the step of acquiring ~~images~~ an image of an area of the substrate includes the steps of:

delivering a pulse of light from a coherent light source onto the area of the substrate; and

utilizing a conventional camera system.

18. (Original) The method of claim 17, wherein said coherent light source comprises a laser.

19. (Currently Amended) The method of claim 15, wherein the step of acquiring ~~images~~ an image of an area of the substrate includes the steps of:

delivering a pulse of light from a broad band light source onto the area of the substrate; and

utilizing a conventional camera.

20. (Original) The method of claim 19, wherein said broad band light source comprises a flash lamp.

21. (Currently Amended) The method of claim 15, wherein the step of converting ~~a corresponding~~ the acquired image into a thickness measurement when the acquired image

corresponds to one of the compared stored image patterns includes the step of converting

pixels of the ~~corresponding~~ acquired image into layer thickness.

22. (Original) The method of claim 15, wherein said determination of end-point during CMP

of a substrate is performed in situ.

23. (Currently Amended) An apparatus for determining end-point of an area of a substrate

during CMP of a the substrate comprising:

 a high speed imager configured to acquire images of the substrate in situ;

 a processing unit in electronic communication with said high speed imager;

 a memory device in electronic communication with said processing unit and

containing a plurality of instructions which, when executed by said processing unit, causes

said processing unit to:

  compare images of the substrate acquire by said high speed imager to image

patterns stored in said memory device;

  convert an acquired image into a layer thickness measurement when said

acquired image corresponds to a selected image pattern stored in said memory device; and

  stopping CMP when the layer thickness measurement equals a predetermined value

indicating end-point.

24. (Original) The apparatus of claim 23, wherein said high speed imager comprises:

 a pulsed, coherent light source; and

a conventional camera.

25. (Original) The apparatus of claim 24, wherein said coherent light source comprises a laser.

26. (Original) The apparatus of claim 23, wherein said high speed imager comprises:

a conventional light source; and

a high speed camera.

27. (Original) The apparatus of claim 23, wherein said high speed imager comprises:

a pulsed, broad band light source; and

a conventional camera.

28. (Currently Amended) The apparatus of claim 27, wherein said broad band light source comprises a flash lamp.

II.   The Present Invention

The present invention is directed to an in situ apparatus and process for determining

film or layer thickness of a particular area of a semiconductor substrate or wafer during

chemical mechanical polishing or planarization (CMP) thereof. The apparatus and process

may be used to determine end-point during CMP, especially of oxide films deposited on the

substrate or wafer.

A high speed imager captures an image of an area of the substrate. The captured

image is compared to a plurality of stored image patterns. The stored image patterns identify

particular areas on the substrate. When the captured image corresponds to one of the stored

image patterns, the area of the substrate is known. If the particular captured image is the

correct or target area, a thickness measurement is then made. By utilizing pattern recognition,

a particular area of the substrate is identified for obtaining a thickness measurement. The

present invention may be utilized to determined end-point of CMP.

II.   The Prior Art Rejection of Claims 1, 2, 8, 9 and 12 Should be Withdrawn

In the Office Action dated April 21, 2003, the Examiner rejected claims 1, 2, 8, 9 and

12 under 35 U.S.C. Section 102(b) as allegedly being anticipated by U.S. Patent No.

5,640,242 to O'Boyle et al. (hereinafter, "O'Boyle").

A.   1. O'Boyle

O'Boyle is directed to an assembly and method for making in process thin film

thickness measurements, particularly during chemical mechanical polishing (CMP). O'Boyle

teaches the use of an optical head and light source to obtain an image of the substrate. The obtained image of the substrate is compared to a set of reference characteristics corresponding to known thickness. The system provides an output corresponding to a thickness of the thin film structure.

B.   The Claims

1. Claim 1

Applicant's independent claim 1 recites:

A method of determining layer thickness of a particular area of a substrate during CMP of the substrate, the method comprising the steps of:
    acquiring an image of a particular area of the substrate using high speed imaging;
    comparing the acquired high speed image to each one of a plurality of stored image patterns; and
    converting the acquired high speed image into a layer thickness measurement when the acquired high speed image corresponds to one of said plurality of stored image patterns.

O'Boyle does not anticipate independent claim 1. It is well settled law that for a reference to anticipate, each and every limitation of the claim must be taught in the reference. Independent claim 1 requires, among other limitations, "comparing the acquired high speed image to each one of a plurality of stored image patterns." O'Boyle is cited by the Examiner for allegedly teaching comparison of an acquired image to a pattern (see 4/21/03 Office Action, page 2). Applicant respectfully submits that O'Boyle does not teach the comparison of an acquired high speed image to each one of a plurality of stored image patterns and thus is not a proper anticipatory reference.

A reading of the cited passage of O'Boyle (i.e. column 3, lines 23-29) indicates that O'Boyle compares his acquired image with a set of reference characteristics corresponding to

known thickness. A set of reference characteristics corresponding to known thickness is not a plurality of stored image patterns as is recited in claim 1. A set of reference characteristics does not equate to a plurality of stored image patterns. Nowhere does O'Boyle teach the comparison of an acquired image with stored image patterns.

In view of the above, it is respectfully submitted that claim 1 cannot be anticipated by O'Boyle, since O'Boyle does not teach each and every limitation of claim 1. Therefore, withdrawal of the rejection to and reconsideration of claim 1 is respectfully requested.

2. Claims 2 and 8

Each of claims 2 and 8 includes independent claim 1 as a base claim. The reasoning set forth above with regard to the patentability of independent claim 1 is thus applicable to the patentability of claims 2 and 8, and is therefore incorporated herein by reference. As a result, each of claims 2 and 8 are allowable over O'Boyle for the reasons hereinbefore discussed with regard to claim 1.

Further, each of claims 2 and 8 includes further limitations that are not taught or disclosed in O'Boyle. Accordingly, reconsideration of claims 2 and 8 including withdrawal of the rejection thereto and allowance thereof is hereby respectfully requested.

3. Claim 9

Applicant's independent claim 9 recites:

An apparatus for determining layer thickness of a particular area of a substrate during CMP of the substrate comprising:

a high speed imager adapted to acquire an image of a particular area of the substrate in situ;

a processing unit in electronic communication with said high speed imager;

memory in electronic communication with said processing unit and containing a plurality of instructions which, when executed by said processing unit, causes said processing unit to:

compare the image acquired by said high speed imager to each one of a plurality of image patterns stored in said memory device; and

convert the acquired image into a layer thickness measurement when said acquired image corresponds to one of said plurality of image patterns stored in said memory device.

Claim 9 is similar in subject matter to claim 1, but in apparatus form. As such, the arguments with respect to the patentability of independent claim 1 are applicable to independent claim 9 and are hereby incorporated herein. Claim 9 includes the limitation of the processing unit comparing the acquired image to each one of a plurality of image patterns stored in the memory device. As pointed out above, O'Boyle does not teach comparing an acquired image with each one of a plurality of image patterns.

In view of the above, it is respectfully submitted that claim 9 cannot be anticipated by O'Boyle. Therefore, withdrawal of the rejection to and reconsideration of claim 9 is respectfully requested.

4. Claim 12

Claim 12 includes independent claim 9 as a base claim. The reasoning set forth above with regard to the patentability of independent claim 9 is thus applicable to the patentability of claim 12, and is therefore incorporated herein by reference. As a result, claim 12 is allowable over O'Boyle for the reasons hereinbefore discussed with regard to claim 9.

Further, claim 12 includes further limitations that are not taught or disclosed in

O'Boyle. Accordingly, reconsideration of claim 12 including withdrawal of the rejection

thereto and allowance thereof is hereby respectfully requested.

III.   The Prior Art Rejection of Claims 3-7, 10-11 and 13-28 Should be Withdrawn

In the Office Action dated April 21, 2003, the Examiner rejected claims 3-7, 10-11 and

13-28 under 35 U.S.C. Section 103(a) as allegedly being unpatentable over U.S. Patent No.

5,640,242 to O'Boyle et al. (hereinafter, "O'Boyle") in view of U.S. Patent 6,361,646 to

Bibby, Jr. et al. (hereinafter, "Bibby").

A.   1. Bibby

Bibby is directed to a method and apparatus for endpoint detection for chemical

mechanical polishing. Bibby generates an endpoint signal to control the polishing of thin

films on a semiconductor wafer surface. A fiber optic cable propagates a light through a

through-hole opening in a polish pad to illuminate the semiconductor surface. A light sensor

receives reflected spectral data that is provided to a computer. The computer receives the

reflected spectral data and calculates an endpoint signal.

B.   The Claims

1. Claims 3-7

Each of claims 3-7 includes claim 1 as a base claim. Therefore, the arguments with

respect to the patentability of claim 1 are applicable to claims 3-7 and are incorporated herein

by reference. It has been shown above that O'Boyle does not teach the limitation of

comparing an acquired image with a plurality of stored image patterns as recited in independent claim 1. Bibby is cited by the Examiner for teaching endpoint detection in CMP. While Bibby does teach a method and apparatus for endpoint detection in CMP, it is clear that Bibby does not teach the limitation of comparing an acquired image with a plurality of stored image patterns as recited in independent claim 1. Therefore, since the combination of O'Boyle and Bibby does not teach or suggest the comparison limitation of independent claim 1, O'Boyle and/or Bibby cannot teach the limitations of dependent claims 3-7.

Moreover, claims 3-7 include further limitations that are not taught or disclosed in O'Boyle and/or Bibby. Accordingly, reconsideration of claims 3-7 including withdrawal of the rejection thereto and allowance thereof is hereby respectfully requested.

2. Claims 10-11 and 13-14

Each of claims 10-11 and 13-14 includes claim 9 as a base claim. Therefore, the arguments with respect to the patentability of claim 9 are applicable to claims 10-11 and 13-14 and are incorporated herein by reference. It has been shown above that O'Boyle does not teach the limitation of comparing an acquired image with a plurality of stored image patterns as recited in independent claim 9. Bibby is cited by the Examiner for teaching endpoint detection in CMP. While Bibby does teach a method and apparatus for endpoint detection in CMP, it is clear that Bibby does not teach the limitation of comparing an acquired image with a plurality of stored image patterns as recited in independent claim 9. Therefore, since the combination of O'Boyle and Bibby does not teach or suggest the comparison limitation of independent claim 9, O'Boyle and/or Bibby cannot teach the limitations of dependent claims

10-11 and 13-14.

Moreover, claims 10-11 and 13-14 include further limitations that are not taught or disclosed in O'Boyle and/or Bibby. Accordingly, reconsideration of claims 10-11 and 13-14 including withdrawal of the rejection thereto and allowance thereof is hereby respectfully requested.

3. Claims 15-22

Claims 15-22 are similar to claims 1-8 and thus the arguments with respect to the patentability of claim 1-8 are applicable to the patentability of claims 15-22 and are thus incorporated herein by reference. Particularly, O'Boyle and Bibby in combination do not teach or suggest comparing an acquired image with a plurality of stored image patterns before calculating a thickness measurement.

Accordingly, reconsideration of claims 15-22 including withdrawal of the rejection thereto and allowance thereof is hereby respectfully requested.
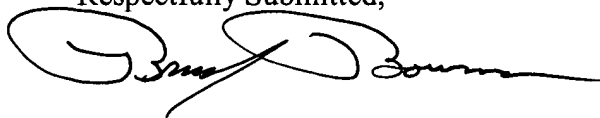
4. Claims 23-28

Claims 23-28 are similar to claims 9-14 and thus the arguments with respect to the patentability of claim 9-14 are applicable to the patentability of claims 23-28 and are thus incorporated herein by reference. Particularly, O'Boyle and Bibby in combination do not teach or suggest comparing an acquired image with a plurality of stored image patterns before calculating a thickness measurement.

Accordingly, reconsideration of claims 23-28 including withdrawal of the rejection thereto and allowance thereof is hereby respectfully requested.

IV.   Conclusion

It is respectfully submitted that all claims are in condition for allowance. Accordingly, prompt and favorable examination is earnestly solicited.

Respectfully Submitted,

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